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# RISKS OF COMPLICATIONS AND STATISTICAL CRITERION OF "ODDS RATIO" (OR) AS INDICATORS OF THE EFFECTIVENESS OF LASER VAPORIZATION OF HEMORRHOIDAL VESSELS

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## Abstract

**Background:** There are many surgical treatments for hemorrhoids. The risk ratio (e.g. odds ratio) associated with performing a particular surgical procedure has not been adequately studied, including laser vaporization. The aim of the study was to investigate the structure of complications after various methods of treating hemorrhoidal disease in patients undergoing treatment and to evaluate the effectiveness of laser vaporization of hemorrhoidal nodes.

**Materials and Methods:** A retrospective and prospective analysis of medical documentation of patients diagnosed with hemorrhoids of stages I-IV, from 2021 to 2024, was conducted. During this period, 1450 operations were performed on patients aged 18 to 70 years. Laser Vaporization was used to perform 1100 hemorrhoidectomies in the main group, the traditional Milligan-Morgan technique was used in 190 operations in the first and 160 hemorrhoidectomies were performed by placing Ligating Rings in the second comparison groups.

**Results:** A total of 1450 operations were performed on patients aged 18 to 70 years. The laser vaporization method was used in 1100 hemorrhoidectomies in the main group, the traditional the Milligan-Morgan hemorrhoidectomy - in 190 operations in the first and 160 hemorrhoidectomies were performed using ligating rings in the second comparison groups.

**Conclusions:** In calculating the "odds ratio", which indicates the likelihood of the presence of any complication after the treatment of hemorrhoidal disease, it was found that patients had the worst odds after the Milligan-Morgan hemorrhoidectomy - 1.025. After Ligation of hemorrhoidal nodes operation - 0.923. The best result in the odds ranking after laser vaporization - 0.920.

**Key words:** *Hemorrhoids, laser vaporization, hemorrhoidectomy, ligation.*

### Introduction

According to global statistics, hemorrhoids are one of the most common human diseases and the most frequent reason for patients to seek a consultation with a colorectal surgeon. At the same time, individual researchers acknowledge that currently, even after many years of research worldwide, there is no complete picture and scale of this disease among the population. It is widely believed that its prevalence ranges from 100 to 150 individuals per 1000 adult population, with hemorrhoids accounting for 20 to 30% of the structure of colorectal diseases. There are numerous methods for treating this disorder, the most common of which are the Milligan-Morgan procedure, ligation of hemorrhoidal nodes, and the HAL-RAR procedure (Hemorrhoidal Artery Ligation and Recto Anal Repair). Each of the aforementioned methods has its own set of advantages and disadvantages and may be associated with various early and late postoperative complications. Recent global data has been comprehensively analyzed and systematized in a review article by Romaguera V.P. et al. in 2021. Thus, among the most frequent complications following operations for hemorrhoidal disease, clinicians attribute pain, urinary retention, and among the most severe are bleeding from anorectal wounds, development of purulent-inflammatory processes, and strictures of the anal canal. Various combinations of complications with significant pain syndrome should also be included in this category. These data are visually presented in figure 1.

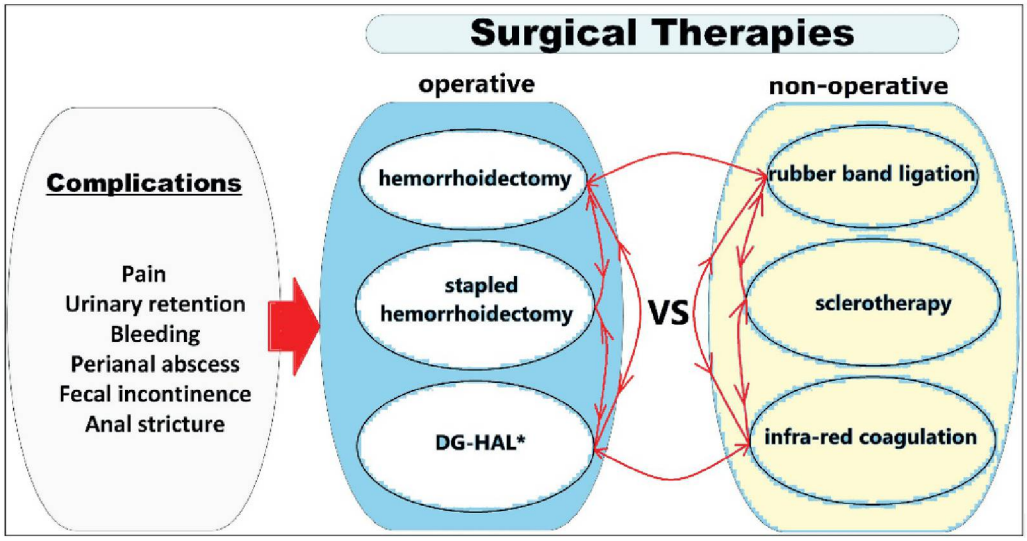


**Figure 1.** Common operations for hemorrhoidal disease and postoperative complications; Doppler-Guided Hemorrhoidal Artery Ligation (the diagram was reconstructed based on the figure by Romaguera VP, Sancho-Muriel J, Alvarez-Sarrdo E, Millan M, Garcia-Granero A, Frasson M., 2021)[5]

In recent 10 years, the outpatient surgery center of the Corporate Foundation "University Medical Center" has actively implemented and used a minimally invasive method for treating hemorrhoidal disease, such as laser vaporization. The accumulated long-term experience of observing patients with hemorrhoids, using various treatment methods, and the lack of a sufficient number of publications comparing postoperative complications have necessitated conducting this scientific analysis. The aim of the study was to investigate the structure of complications after various methods of treating hemorrhoidal disease in patients undergoing treatment and to evaluate the effectiveness of laser vaporization of hemorrhoidal nodes.

**Material and methods**

A retrospective and prospective analysis of medical documentation of patients diagnosed with hemorrhoids of stages I-IV, who were treated at "UMC" (Outpatient Surgery Department) from 2021 to 2024, was conducted. During this period, 1450 operations were performed on patients aged 18 to 70 years. Among them, there were 5 teenagers (according to the WHO classification of 2022, individuals up to 19 years old are considered teenagers), which accounted for approximately 0.34% of the total number of patients. In the age groups of 20-24 and 25-44 years (the younger age group), 139 (9.59%) individuals were operated on, in the range from 44 to 60 (the average age 52.0±7.3) – 998 (68.83%); from 60 to 75 (elderly people) – 308 (21.24%). Among women, the frequency of surgical interventions was 60.3%, while among men, it was 39.7%. Laser vaporization (LV) was used to perform 1100 hemorrhoidectomies (main observation group), the traditional Milligan-Morgan hemorrhoidectomy (MMHE) technique was used in 190 operations (comparison group 1), and 160 hemorrhoidectomies were performed by placing ligation of hemorrhoidal (LH) nodes (comparison group 2).

**Ethical Approval:** Permission was obtained from the local ethical commission of the NJSC «Astana Medical University» to conduct this study (Protocol No. 9; 29.11.2023)

**Statistical analysis:** In the first stage of data processing obtained from the electronic database (patients' medical records), the "Microsoft Excel - XLSTAT" analytical application was used. In the second stage, after studying and analyzing descriptive statistical functions, calculations were conducted using statistical programs Statistica-12 and IBM SPSS Statistics. T-Student's criterion, Pearson's chi-squared test, non-parametric statistical criterion Mann-Whitney-U test, analysis of variance ANOVA (for comparing mean values of three or more groups), as well as the Kruskal-Wallis criterion were used for comparing rank characteristics of three or more groups, which does not require normality of data distribution during calculations. The above methods made it possible to objectively and reliably evaluate the statistics of postoperative complications.

**Results**

The recurrence rate after laser vaporization was 32 cases, which corresponds to 2.9% of the total number of operations. Early and late postoperative complications were observed in 20 cases, constituting 1.8%. There were 10 cases of bleeding from the anal canal within the first 24 hours after the operation and 2 cases within the first 10 days. This complication was the most common after laser vaporization, accounting for 60% of the total number of complications and 1% of the total number of operations. Later complications included anal canal strictures - 2 cases (0.18%) and the development of paraproctitis in 6 cases (0.54%). The recurrence rate after Milligan-Morgan's operation was 37 cases (19.47%). Complications were observed in 22 individuals (11.57%). Bleeding occurred in the early postoperative period in 9 patients, accounting for 4.7%. One case of perianal hematoma was detected (0.52%). In the late period, anal canal stricture was noted in 4 patients (2.1%), and paraproctitis was diagnosed in 8 operated individuals (4.2%). It is noteworthy that 78 patients experienced significant pain syndrome (41%).

The fewest number of operations was performed using the method of applying ligating rings, which, similar to the Milligan-Morgan operation, showed a higher recurrence rate and complications. Recurrences amounted to 22 cases (13.75%). Complications were observed in 19 individuals (11.8%). Bleeding occurred in 9 patients (5.6%) within the first week after the operation. Purulent-inflammatory processes were observed in 5 patients (3.12%) within 1-3 months after the surgical intervention. Anal fissure developed in 4 patients (6.6%), and a single case of formation of a subcutaneous posterior rectal fistula was noted (0.62%). During the early postoperative period, 40 patients complained of significant pain syndrome (25%).The frequency of complications depending on the applied method of treating hemorrhoidal disease is presented in the form of a graph in figure 2.

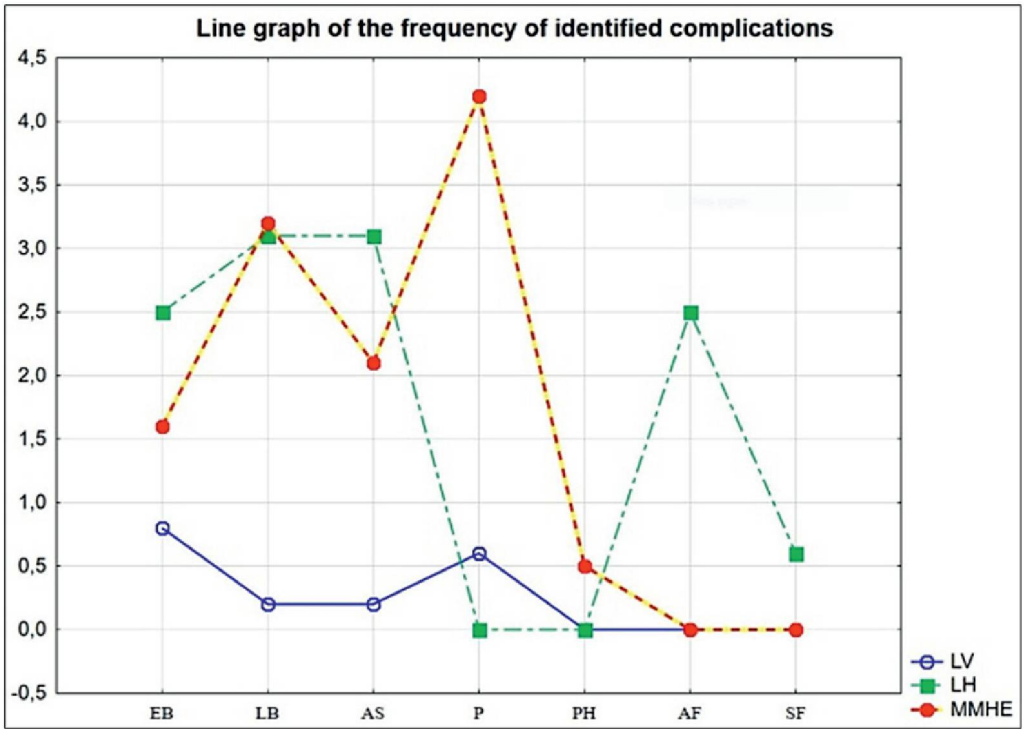


**Figure 2.** Indicators of the frequency of various complications after LV, LH, and MMHE. Where, AF - Anal Fissure; AS - Anal stricture; EB - Early postoperative bleeding; LV - Laser vaporization of hemorrhoidal nodes; LB - Late postoperative bleeding; LH - Ligation of hemorrhoidal nodes; MMHE - Milligan-Morgan hemorrhoidectomy; NC - no complications; P – Paraproctitis; PH - Perianal Hematoma; SF- Subcutaneous rectal fistula.

All complications were confirmed by colonoscopy. Medical conclusions were based on the analysis of the endoscopic picture of the colon after surgery. Examples of complications identified after various types of surgery are shown in figure 3.

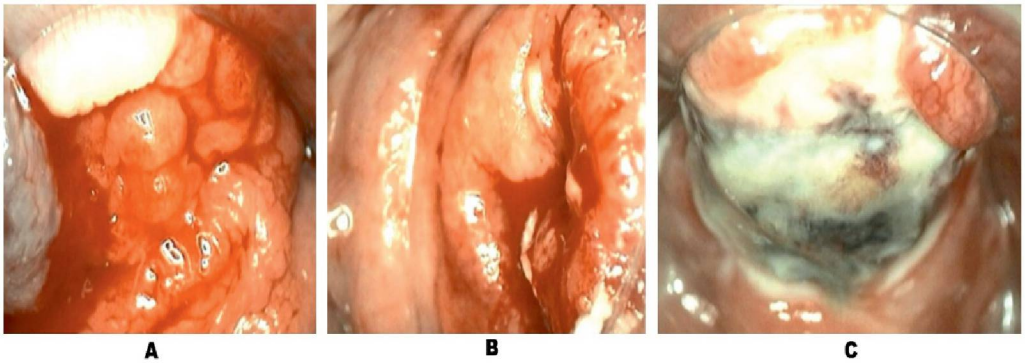


**Figure 3.** Where, A - postoperative perianal edema and hematoma; B - postoperative bleeding; C - postoperative suppuration.

Visual assessment of the intestinal mucosa and complications was carried out not only by the proctologist who performed the surgery. A group of 5 experts (surgeons, endoscopists, proctologists, gastroenterologists, pathologists) were additionally involved in the analysis, who helped to objectively diagnose the severity of the complication, its type, stage, etc. As a result of further analysis and processing of statistical data, parameters of the registered frequency of complications to the expected frequency (probability of complication types) depending on the treatment methods were determined. Despite the convincing numbers and reliable conclusions obtained from comparing different surgical methods, we studied the comparability of groups based on key statistical parameters. Due to the unequal number of patients in the compared groups (LV = 1100; MMHE =190; LH =160), we additionally used "Hochberg's GT-2 test". As a result, the validity of the results indicating the compara-

bility of the studied groups was confirmed. The comparison was conducted based on gender, patients' age, duration of medical history, frequency of hemorrhoidal complications, recurrence rate, nature of postoperative complaints, etc. To check the complication statistics, calculations were then repeated in groups with an equal number of patients. For this purpose, a random sampling method was applied. It was determined that a sample size of N=150 for each group of operated patients (LV, MMHE, LH) was optimal (p-value ≤0.05). All calculations confirmed the reliability of the previously obtained results (in terms of both the frequency and probability of postoperative complications and other parameters). The ratio of complication frequencies (including expected complications) is systematized in table 1.

**Table 1.**
Ratio of Complication Frequencies Depending on Treatment Method

| Treatment Method | Complication Frequency / Expected Frequency / in % | Type of Complication | | | | | | | NC (no complications) | Total (operated patients) |
|---|---|---|---|---|---|---|---|---|---|---|
| | | EB | LB | AS | P | PH | AF | SF | | |
| LV | F/EF | 0.8 | 0.2 | 0.2 | 0.6 | 0.0 | 0.0 | 0.0 | 98.2% | N=150 |
| MMHE | F/EF | 1.6 | 3.2 | 2.1 | 4.2 | 0.5 | 0.0 | 0.0 | 88.4% | N=150 |
| LH | F/EF | 2.5 | 3.1 | 3.1 | 0.0 | 0.0 | 2.5 | 0.6 | 88.1 | N=150 |

AF - Anal Fissure; AS - Anal stricture; LV - Laser vaporization of hemorrhoidal nodes; EB - Early postoperative bleeding; LB - Late postoperative bleeding; LH - Ligation of hemorrhoidal nodes; MMHE - Milligan-Morgan hemorrhoidectomy; NC - no complications; P – Paraproctitis; PH – Perianal; Hematoma; SF - Subcutaneous rectal fistula

In the presented table, the frequency of so-called "expected" complications indicates the possible likelihood of a particular event. According to our data, in most cases, the actual figures for complicated cases were lower than what was anticipated from mathematical (statistical) calculations. The lowest complication rates recorded in the clinic were associated with the LV operation.

For comparative assessment of the risk of complications, we also used the Surgical Risk Calculator *(ACS NSQIP - American College of Surgeons National Surgical Quality Improvement Program, Version: 4.0.2; Last parameter update: April 2025).* The selection of the aforementioned calculator for our study was based on our experience using it. In previous years, it has demonstrated high and reliable accuracy. It should be noted that the Risk Calculator was built using data collected from over 5.0 million operations from 874 hospitals participating in ACS NSQIP from 2016-20. Therefore, the results obtained using this calculator will make an invaluable contribution to our research process.

We found the following surgical procedures (hemorrhoids, anus) with their code numbers: Procedure 46250 - Hemorrhoidectomy, external;

Procedure 46255 - Hemorrhoidectomy, internal and external, single column/group;

Procedure 46257 - Hemorrhoidectomy, internal and external, single column/group; with fissurectomy;

Procedure 46258 - Hemorrhoidectomy, internal and external, single column/group; with fistulectomy, including fissurectomy,when performed;

Procedure 46260 - Hemorrhoidectomy, internal and external, 2 or more columns/groups; Procedure 46261 - Hemorrhoidectomy, internal and external, 2 or more columns/groups; with fissurectomy;

Procedure 46262 - Hemorrhoidectomy, internal and external, 2 or more columns/groups; with fistulectomy, including fissurectomy, when performed;

Procedure 46945 - Hemorrhoidectomy, internal by ligation other than rubber band; single hemorrhoid column/group;

Procedure 46946 - Hemorrhoidectomy, internal, by ligation other than rubber band, 2 or more columns/groups;

Procedure 46947 - Hemorrhoidopexy by stapling (eg, for prolapsing internal hemorrhoids);

Procedure 46262 - Hemorrhoidectomy, internal and external, 2 or more columns/groups; with fistulectomy, including fissurectomy, when performed;

Procedure 46924 - Destruction of lesion(s), anus (eg, condyloma, papilloma, molluscum contagiosum, herpetic vesicle), extensive (eg, laser surgery, electrosurgery, cryosurgery, chemosurgery);

46750 - Sphincteroplasty, anal, for incontinence or prolapse; adult;

46761 - Sphincteroplasty, anal, for incontinence, adult; levator muscle imbrication (Park posterior anal repair);

45190 - Destruction of rectal tumor (eg, electrodesiccation, electrosurgery, laser ablation, laser resection, cryosurgery) transanal approach;

Procedure 46930 - Destruction of internal hemorrhoid(s) by thermal energy (eg, infrared coagulation, cautery, radiofrequency).

Certain procedures are not listed in the risk calculator database ACS NSQIP. In accordance with the recommendations, we have substituted their the following NSQIP Procedure, which we believe exhibits a similar risk profile. In this case, it is incumbent on the surgeon to consider the clinical appropriateness of this substitution and to adjust risk estimates if deemed necessary. The above recommendations were implemented by us, together with a group of medical experts.

Studies (mathematical calculations) has confirmed that the risks of most hemorrhoidectomies are equivalent to those of two surgeries: 46940 - Curettage or cautery of anal fissure, including dilation of anal sphincter (separate procedure); initial Procedure 46947 - He-

morrhoidopexy by stapling (eg, for prolapsing internal hemorrhoids).

And the risk of surgery (Procedure 46930 - Destruction of internal hemorrhoid(s) by thermal energy (eg, infrared coagulation, cautery, radiofrequency) corresponds to the risk of surgery 46940 Curettage or cautery of anal fissure.

When determining the risk indicator for surgery, calculations were made taking into account the average (ideal) patient (male, 52 years old, without comorbid diseases). Risk Indicator for LV - Laser vaporization of hemorrhoidal nodes, the average risk (combined for 19 outcomes) was he lowest, insignificant-0.55. For MMHE - Milligan-Morgan hemorrhoidectomy and LH - Ligation of hemorrhoidal nodes, the average risk was significantly higher-0.76. This indicator corresponded to surgery Procedure 46947 - Hemorrhoidopexy by stapling.For comparison, it can be noted that the risk of the operation "45190 - Destruction of rectal tumor (eg, electrodesiccation, electrosurgery, laser ablation, laser resection, cryosurgery) transanal approach" is even higher - 1.23.

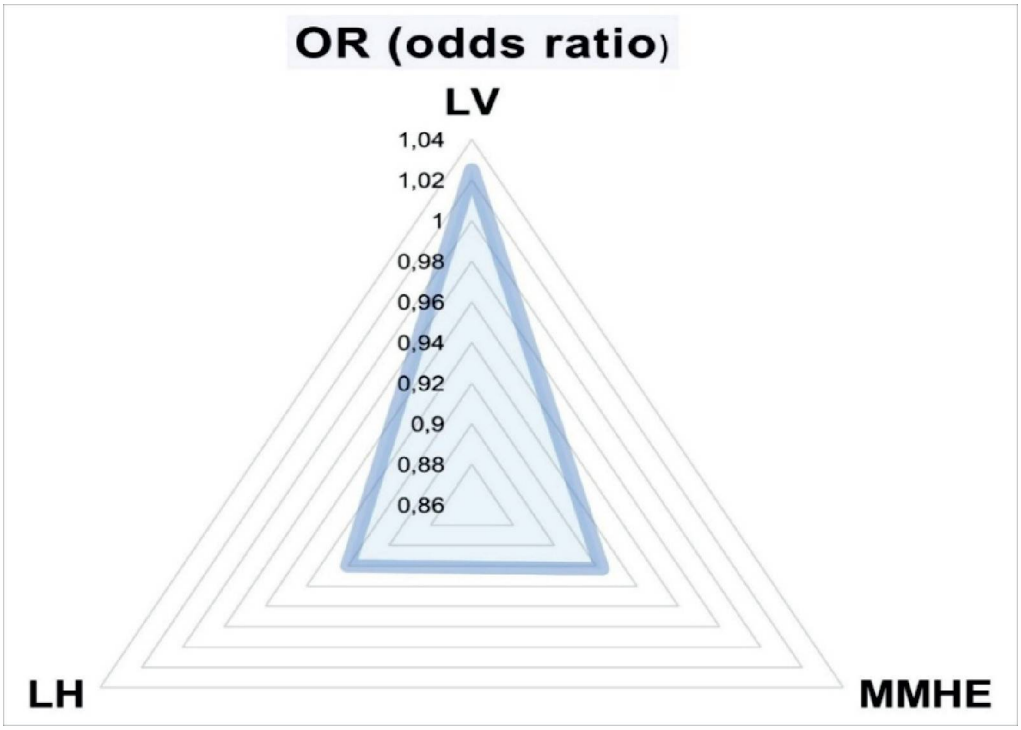


**Figure 4.**
Indicators of the odds ratio (OR) of absence of complications after treatment Where, LV - Laser vaporization of hemorrhoidal nodes; LH - Ligation of hemorrhoidal nodes; MMHE - Milligan- Morgan hemorrhoidectomy.

In calculating the "odds ratio" (OR), which indicates the likelihood of the presence of any complication after the treatment of hemorrhoidal disease, it was found that patients had the worst odds after MMHE - 1.025. Then, after LH operation - 0.923. The best result in the odds ranking after LV (laser vaporization) - 0.920. The obtained results are graphically presented in figures 2 and 4.

**Discussion**

In the modern world, the arsenal of surgical methods for treating hemorrhoids is not very extensive. Many authors limit their studies to comparing one surgical method with another. Or they study only a few postoperative indicators (e.g. postoperative pain, cost-effectiveness, etc.). *Cemil A. et.al. (2024)* believes that laser treatment (LH) of hemorrhoidal disease has no advantages over traditional Milligan-Morgan (MM) surgery.[6] In their article, the authors conclude: "We believe that it is not an advantageous method compared to MM hemorrhoidectomy, both in terms of patient comfort and cost-effectiveness, since postoperative pain, which is shown as the most important advantage of LH over conventional hemorrhoidectomy methods in the literature, can be relieved with simple NSA-I rescue analgesia in patients undergoing MM". The study of other indicators of the effectiveness of various lasers in the treatment of hemorrhoidal varicose veins is presented in the meta-analysis of *Cheng P-L et al. (2024).* [7]After comparing methods (LH, Milligan-Morgan and Ferguson hemorrhoidectomy), the opposite conclusion was made. They write: "This systematic review and meta-analysis of 17 trials revealed that laser hemorrhiodioplasty not only benefits patients through reduced operative blood loss, decreased postoperative pain score on day 1, and lower risks of postoperative hemorrhage and anal stenosis, but also benefits the providers with shorter operation time".[7]

Some studies compare open and minimally invasive laser hemorrhoidectomy, length of hospital stay and other parameters.[8,9] *Lie H, et al,* note that hemorrhoidectomy using a proctologic laser offers a quicker recovery with a shorter hospital stay. However, it does not indicate which method (power, dose) of intraoperative laser exposure was used. Was it laser hemorrhoid excision, intravascular ablation,

Laser Haemorrhoidoplasty, Hemorrhoid laser dearterialization, Laser Intra-Hemorrhoidal Coagulation or vaporization? It should be noted that today, despite the many names, the problem with the terms and classification of surgical treatment remains unresolved.

The most common methods are conventional hemorrhoidectomy (Milligan-Morgan-MMHE), stapled hemorrhoidopexy (SH), transanal hemorrhoidal dearterialization (THD), and Doppler-guided hemorrhoidal arterial ligation (DGHAL) with rectoanal repair.[10,11,12,13,14] All methods are quite effective but at the same time have numerous drawbacks. For example, traditional hemorrhoidectomy involves excision of internal and external hemorrhoidal formations with surrounding tissues, leading to significant postoperative pain in some cases (up to 65.5%).[15] These complications can be avoided by using the popular sclerotherapy procedure, which is performed without tissue excision, limiting to the injection of a sclerosant.[16] However, its effectiveness decreases over time, often resulting in recurrences. According to *Balciscueta Z. et al. (2021),* reducing the frequency of postoperative pain can be achieved by performing so-called closed hemorrhoidectomy with bipolar or ultrasound coagulation, and avoiding transfixal ligation of the hemorrhoidal pedicle.[17]

The endoscopic method of infrared coagulation therapy is performed without surgical tissue excision, but its effectiveness is currently insufficient, not exceeding 87.6%. Complications such as bleeding (up to 2%), anal prolapse, and the need for reoperation occur after treatment. Some authors do not see a significant difference between traditional hemorrhoidectomy and minimally invasive surgeries. Moreover, the THD procedure is more complex, with a 15% recurrence rate after 3 years. For instance, *Pietro Genova (2019)* concluded that for grade III hemorrhoids, the THD technique provides similar results to MM, while for grade IV hemorrhoids, better results can be achieved with the MM technique.[18] According to *Rørvik HD et al. (2020),* postoperative prolapse and repeat treatment for recurrence after transanal hemorrhoidal dearterialization were significantly higher than after traditional open hemorrhoidectomy (7 vs. 0 patients; p = 0.013).[19]

Our studies have shown significantly better results. Recurrences with minimally invasive treatment of hemorrhoidal disease were observed in 2.9%, and complications in 1.8%, whereas with the traditional Milligan-Morgan operation, the recurrence rate was 19.47%, and complications were 11.57%. With the procedure of ligation of varicose veins of the rectum, the recurrence and complication rates were 13.75% and 11.8% respectively.

However, there are authors who do not believe in the advantages of the laser vaporization method. For example, *Cemil A. et.al. (2024)* argue: «LV is not an advantageous method compared to MM hemorrhoidectomy».[6] *Smets. Q et al. (2024)*[20] point out possible serious complications after the laser procedure: perforation, eading to an acute abdomen, sepsis, and multiorgan failure. The authors point out that major complications likely attributed to collateral thermic and mechanical tissue damage.[20] Nevertheless, our observations are in line with the studies and conclusions of *Wee IJY et al. (2023)*[21], indicating that LV results in improved clinical outcomes in the short term, with reduced morbidity, pain, and earlier return to work or daily activities, as well as similar medium-term symptom recurrence rates compared to CH (conventional hemorrhoidectomy).[21]

Our study, like many others *(Harvitkar R.U., et al, 2021)*[22], has identified the advantages of the laser method. Some authors claim that this technique is also minimally invasive, does not require anesthesia, and can be performed as an outpatient procedure.[22] Our study can help the surgeon to determine all the risks that await the patient in the future before the operation. It should also be noted that in the observation we presented, all operations (procedures) were performed on an outpatient basis (in the so-called "one-day department"), which has specialists in the use of laser surgery in other areas of medicine.[23] Therefore, patients can be discharged home even faster than when using the "Fast-track surgery" principle.

However, despite a sufficient amount of scientific data related to the treatment of hemorrhoidal disease, we did not find studies that specifically examined the likelihood of complications using the "odds ratio" (OR) in calculations. Nor did we find comparisons of this indicator in LV treatment compared to other methods such as MMHE and LH. Therefore, our results can be considered unique, in which we determined the following: In calculating the "odds ratio" (OR), which indicates the likelihood of the presence of any complication after the treatment of hemorrhoidal disease, it was found that the best result in the odds ranking was after LV.

**Limitations.** The study excluded patients with acute/subacute anal or perirectal pathology, hemorrhoidal bleeding, recurrences after previous hemorrhoidectomy, cicatricial strictures, or scars from purulent paraproctitis. Patients who did not comply with the postoperative examination schedule were also excluded. At the same time, when examining patients, we were aware of the risk that not all patients might conscientiously report, for example, the use of antibiotics to prevent suppuration. When analyzing the risk of complications using our method, data on diabetes mellitus, glycemic levels, etc. were not taken into account, which may well influence the results.

**What's known?** Studies have previously been conducted worldwide to determine the risk of complications after various hemorrhoidal surgeries. However, the results are rather fragmented and sparse. Researchers have mostly focused on traditional surgeries such as Milligan-Morgan hemorrhoidectomy and compared them with laser coagulation, ultrasound-assisted dissection, and other procedures. These studies have primarily been conducted in hospital settings, and very rarely in ou-

tpatient settings, including in so-called "same-day hospitals." Furthermore, a combination of odds ratio calculations and the ACS NSQIP risk calculator has not yet been used, according to the literature.

**What's new?** This study attempts to compare the risks of complications after traditional surgical methods with those after hemorrhoid vaporization. The results obtained are evaluated for the first time using risk calculations (odds ratios) and comparisons with the results obtained using the ACS NSQIP. The combination of methods and comparison of results complements the scientific evidence on the benefits of laser vaporization. Furthermore, the reliability of the results is beyond doubt.

**Conclusions**

Analysis of the structure of complications leads to the conclusion that laser vaporization shows higher effectiveness compared to other methods of treating chronic hemorrhoids. The use of laser vaporization has significantly reduced the number of risks complications and relapses compared to other methods of treating hemorrhoids. In calculating the "odds ratio" (OR), which indicates the likelihood of the presence of any complication after the treatment of hemorrhoidal disease, it was found that patients had the worst odds after MMHE - 1.025. Then, after LH operation - 0.923. The best result in the odds ranking after LV (laser vaporization) - 0.920

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